PATENT SPECIFICATION 620,652

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COMPLETE SPECIFICATION

Improvements in or relating to Injection-Moulding or Extrusion Apparatus

(Communication from CHRYSLER CORPORATION, a corporation organised under the laws of the State of Delaware, United States of America, of 341, Massachusetts Avenue, Highland Park, Michigan, United States of America.)

I, ARTHUR HAROLD STEVENS, a British Subject, of the Firm of Stevens, Langner, Parry & Rollinson, Chartered Patent Agents, of 5/9, Quality Court, Chancery Lane, London, W.C.2, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to apparatus for injection-moulding or extrusion of material under pressure and is a division of copending application for letters patent No. 24035/44.

In accordance with the invention, there is provided apparatus for injection-moulding or extrusion of material under pressure comprising housing means having a cylindrical bore therein forming a pressure chamber and having an inlet for said material and outlet for the latter spaced axially of said bore, a rotatable screw in said bore having a conveyor-like worm thread extending between said inlet and outlet, mechanism for drivingly rotating said screw, the wall of said bore having a laterally extending externally closed recess therein communicating with said bore at a location spaced from the inlet end of the latter a distance corresponding to more than one complete turn of the thread of said screw, whereby direct communication in an axial direction between said recess and said inlet is prevented in all angular positions of said screw, and a gear-like member rotatably mounted in said recess having an axis extending relatively transversely of the axis of said screw in fixed spaced relation thereto and having teeth-like elements meshed with the thread of said screw in worm and gear relationship and adapted to successively cut into the material contents of the groove of said screw during rotation of said screw in order to positively hold said material against turning with said screw and to thus cause said material to be impelled by said screw axially of the latter.

In order that the invention may be clearly understood and readily carried into effect the same will now be described more fully with reference to the accompanying drawings, in which:

Fig. 1 is a vertical sectional view of injection molding apparatus embodying the invention.

Fig. 2 is a transverse sectional view taken on line 2—2 of Fig. 1.

Fig. 3 is a fragmentary, vertical sectional view of the driving mechanism for propelling the pressure-creating apparatus of the injecting unit, showing portions of the device for feeding moldable material thereto.

Fig. 4 is a vertical sectional view similar to Fig. 1 of a modified form of injecting apparatus which also embodies the invention.

Referring to the injecting apparatus of Figs. 1 to 3 of the drawings, although it it shown associated with a mold structure, it can be readily applied to an extruding die. The injecting apparatus, best shown in Fig. 1, comprises a tubular body portion, generally designated by the numeral 10, having an upper section 11, an intermediate section 12, and a heating chamber 13 to which is attached a nozzle body 14 having a discharge nozzle element 15 attached to its extreme end.

The intermediate section 12 is provided with a cylindrical bore 16 which is axially aligned with the passage 17 in the heating chamber as well as with the discharge passages 18 and 19 of the nozzle body 14

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and nozzle element 15, respectively. A conveyor-like screw 20 extends through the bore 16 and is provided with a thread 21 which relatively closely fits the wall of the bore 16 and which extends through the interior of the upper section 11 to a location adjacent the lower extremity of the intermediate section 12 of the apparatus. Provided on respectively opposite sides of the bore 16 are chambers 22 and 23 which are formed in part by slots 24 and 25, respectively provided through the wall structure of the intermediate section 12, and in part by semi-circular recesses 26 and 27 of caps 28 and 29, respectively, which are mounted on the sides of the intermediate section 12 in alignment with the slots 24 and 25 thereof. There are provided between the upper ends of the chambers 22 and 23, and the inlet end of the cylindrical bore 16, a plurality of turns of the screw 20.

Rotatably mounted in each chamber 22 and 23 is a gear-like element 30 and 31, respectively, having teeth mashed with the thread 21 of the screw 20 in a worm and gear relationship. As will be apparent from Fig. 2, the inner surfaces of the recesses 26 and 27 have a shape corresponding to the transverse cross section of the teeth of the gear-like elements 30 and 31, and the teeth fit said recess sufficiently close to preclude the flow of material. Each of the gears 30 and 31 has bosses 33, Fig. 2, extending from their opposite sides which are journalled in apertures 34 formed partially in the wall structure of the intermediate section 12 and partly in the caps 28 and 29. The bosses 33 are rotatably received within bearing elements 35 disposed in the apertures 34 which are held against axial displacement in the apertures 34 by plugs 36 and 37. The plug 36 comprises a metal disc having its peripheral portion seated in a groove 38 formed in the wall structure of the intermediate section 12 and associated cap. The plug 37 comprises a metal sleeve having a radially extending flange 39 seated in a groove 40 similar to the groove 38. The plug 37 is provided with a central threaded aperture in which a threaded plug 41 is disposed. The plug 41 engages the extremity of one boss 33 of each gear and serves to hold the opposite extremity of the other boss 33 thereof against an abutment 42 provided on the inner side of the plug 36. The plug 41 is provided with a plurality of radially extending apertures 341 which are registerable with a bore 342 formed in the bearing cap. A set screw 343 having an elongated stem extending into the bore 342 is adapted to be engaged in one of the apertures 341 for the purpose of positively locking the plug 41 in an adjusted position.

The gears 30 and 31 serve as rotatable dams and the teeth thereof extend into the groove of the thread 21 of the screw 20 to positively oppose turning of material operated upon by the thread of the screw with the latter. In this manner, a pressure is positively built up upon the material within the bore 16 of the intermediate section 12, as well as upon the material contained in the passage 17 of the heating member 13. The teeth of the gears 30 and 31 are meshed with the thread 21 of the screw 20 at a location spaced from the inlet end 43 of the intermediate section 12. There is at least one complete full turn of the thread of the screw 20 which is in close fitting relationship with respect to the wall of the bore 16 between the inlet end of the bore 16 and the location at which the slots 24 and 25 communicate therewith. With this construction any material operated upon by the screw which is displaced from the bore 16 by reason of its being carried between the teeth of the gears 30 and 31, is returned to the bore at a location at which the material is at least initially compressed by the thread of the screw. Therefore, the moldable material which thus flows through the chambers 22 and 23 is not removed from a zone of high pressure to a zone of atmospheric pressure and accordingly compressive work which has been done on this material is not lost. Grooves are shown on each side of the bore in Fig. 1. These grooves are accentuated in Fig. 1 and are of such slight dimensions and their lower ends are so spaced from the gear chambers, that they do not cause leakage of material or provide any communication between the chambers in which the gears are disposed and the inlet chamber of the apparatus. The purpose of the grooves is to prevent turning of the material in the thread of the screw at the very entrance to the bore.

The nozzle body 14 has a tapered passage 44 leading from the passage 17 of the heating member 13 to the passage 18 which in turn communicates with the outlet passage 19 of the nozzle element 15. Mounted in the nozzle body 14 is a valve mechanism comprising a valve element 45 having a passage extending diametrically therethrough for accommodating the flow of material under compression through the passage 18 in the nozzle body and through the discharge passage 19 of the nozzle element 15.

The heating member 13 is provided with heating elements 50 and 51 and a spreader 52 is attached to the lower end of

the screw 20 so as to bring the material into close contact with the wall of the heating unit. The spreader 52 has a tapered lower end portion which extends into the tapered passage 44 of the nozzle body. The lower end portion of the spreader 52 is provided with arcuately spaced radially extending blades 53 which contact the walls of the passage 17 and the conical-shaped wall of the tapered passage 44 to retain the spreader in axial alignment with the passage 17. The spreader is thus maintained in a central portion throughout its length so as to bring a layer of plastic material of uniform thickness into heat receiving relationship with respect to the heated walls of the heating unit, thereby uniformly heating the plastic material as it passes through the heating unit.

The mechanism for driving the screw 20 and gears 30 and 31 is shown in Fig. 3 to include an electric motor 54 having a shaft 55 on which is mounted a pinion 56. The pinion 56 is meshed with the gear 57 which is fixed to a shaft 58. The shaft 58 is journalled in bearings 59 and 60 which are mounted in a transmission housing, generally designated by the numeral 61, comprising a body portion 62 and a cover portion 63. The motor 54 is suspended from the body portion 62 of the transmission housing by bolts 64, as illustrated in Fig. 3. A pinion 65 fixed to the shaft 58 which is rotated by the gear 57, is meshed with a gear 66. The gear 66 is keyed to a spindle 67 journalled in bearings 68 and 69 mounted respectively in the cover 63 and body portion 62 of the transmission housing. The spindle 67 is axially aligned with the screw 20 and with the bore 16 in which the screw 20 is received. This spisdle has a coupling 70 on its lower end to which the upper end of the screw 20 is nonrotatably fixed by a pin 71. The transmission housing 61 is spaced vertically from the intermediate section 12 of the injecting apparatus and is detachably connected with the intermediate section 12 by a tubular structure, preferably formed integral with the transmission housing body portion 62 and which has heretofore been designated the upper section of the injecting unit.

A chamber 72 within the tubular upper section 11 serves as an inlet chamber for the purpose of receiving material to be operated upon by the screw and discharged from the injecting apparatus. Formed in the wall of the upper section 11 is an opening 78 for accommodating feeding of material to the chamber 72. A hopper 79 is mounted on the side of the apparatus in registration with the opening 78. This hopper has an upper end portion which is flared outwardly for receiving material from a duct 80 which has a funnel-shaped upper end portion into which the material may be introduced from a container or other source.

Rotatably mounted in the hopper 79 is a feeding drum 82 having vanes 83 extending from its periphery. The drum 82 is carried by shaft 84 journalled in bearings, not shown, mounted on the side walls of the hopper. A pulley 87 fixed to the shaft 84 is drivingly connected by a belt 88, Fig. 3, which passes around a pulley 89 mounted on a shaft 90^1 which, as shown in Fig. 1, is journalled in a bearing 90 extending through the wall structure of the upper section 11. A bevelled pinion 91 is provided on the internal end of the shaft 90^1 and meshes with the bevelled gear 92 which is carried by the spindle 67 and rotated therewith. The entire hopper and feeding drum unit may be conveniently attached to the injecting unit by providing flanges 93, Fig. 3, on the side walls of the hopper 79 which are adapted to be secured to the side of the upper section 11 in which the opening 78 is formed. The feeding drum 82 is thus rotated in timed relation to rotation of the screw 20 and serves to transfer material from the hopper 79 to the chamber 72 from which such material passes into the upper flared end 43 of the bore 16.

The quantity of material thus delivered to the chamber 72 per rotation of the screw 20 may be variably predetermined by adjustably positioning a gate 94 which is shiftably mounted above the feeding drum 82. This gate is adapted to variably predetermine the size of the opening between the hopper and the drum 82 through which the material passes in its travel to the chamber 72.

The form of apparatus shown in Fig. 4 is particularly adapted for injecting rubber compounds into a mold or through an extruding die. The apparatus is similar in character to the form of apparatus shown in Figs. 1—3 and the main difference consists in utilizing the end of the conveyor screw 220 as a valve 430 to seat upon a conical surface 431 of the nozzle body 214 in place of the valve element 45 of the previously described apparatus.

In order to derive this valve action, the screw 220 is axially shiftably connected to the coupling 270 on the lower end of the spindle 267 by a pin 271 which extends through a slot in the shank of the screw 220. The screw is spring-pressed downwardly by a coil spring 432 which is confined in a bore 275 in the coupling 270

and which bears between the end of the bore and the upper extremity of the shank of the screw 220. In operation the screw 220 may be rotated in a reverse direction in order to relieve the pressure on the plastic in the pressure chamber the resulting back pressure tending to urge the screw 220 downwardly in order to seat the valve end 430 of the screw 220 upon the conical seat 431.

In this form of the invention in which the screw 220 is shiftable longitudinally relative to the bore in which it is mounted there is also provided between the inlet end of the bore and the location at which which the bore communicates with the recesses in which the gears 230 and 231 are contained, more than one complete turn of the thread of the screw. As in the form of the invention shown in Figs. 1 to 3, this relationship between the thread of the screw and the inlet of the bore and the location at which the gear containing recesses meets with the bore of the screw provides an effective seal which prevents moldable material under compression in the recesses from flowing upwardly and outwardly to the inlet end of the bore. The compressive work which has been done upon the moldable material by the time it reaches the region of the recesses is therefore not wasted by permitting such material to flow to a zone of atmospherical pressure.

It will be understood that various modifications may be made in the specific embodiments described without departing from the scope of the invention.

Having now particularly described and ascertained the nature of my said invention, (as communicated to me by my foreign correspondents), and in what manner the same is to be performed, I declare that what I claim is:—

1. Apparatus for injection-moulding or extrusion of material under pressure comprising housing means having a cylindrical bore therein forming a pressure chamber and having an inlet for said material and outlet for the latter spaced axially of said bore, a rotatable screw in said bore having a conveyor-like worm thread extending between said inlet and outlet, mechanism for drivingly rotating said screw, the wall of said bore having a laterally extending externally closed recess therein communicating with said bore at a location spaced from the inlet end of the latter a distance corresponding to more than one complete turn of the thread of said screw, whereby direct communication in an axial direction between said recess and said inlet is prevented in all angular positions of said screw, and a gear-like member rotatably mounted in said recess having an axis extending relatively transversely of the axis of said screw in fixed spaced relation thereto and having teeth-like elements meshed with the thread of said screw in worm and gear relationship and adapted to successively cut into the material contents of the groove of said screw during rotation of said screw in order to positively hold said material against turning with said screw and to thus cause said material to be impelled by said screw axially of the latter.

2. Apparatus according to claim 1, in which a substantially semi-circular hollow housing portion forms a closure for said recess.

3. Apparatus according to claim 1, in which the inner surfaces of said recesses have a shape corresponding to the ransverse cross section of said teeth-like elements and fitting said gear-like member sufficiently close to substantially preclude the flow of material from said bore into said rescess.

4. Apparatus according to any of the preceding claims, in which a nozzle having a discharge passage communicates with the outlet of said pressure chamber.

5. Apparatus according to any of the preceding claims, in which a plurality of complete turns of the thread of said screw is disposed between the inlet end of said bore and the end of said recess adjacent said inlet end of said bore.

6. Apparatus according to any of the preceding claims, in which said gear-like member is adapted to return plastic material carried by it to a zone of said bore from which free flow of such plastic material toward said inlet is obstructed by the thread of said screw in all angular positions of the latter in its path of rotative movement.

7. Apparatus for injecting plastic under pressure substantially as hereinbefore described.

Dated the 31st day of October, 1947.
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SHEET 1

[This Drawing is a reproduction of the Original on a reduced scale.]

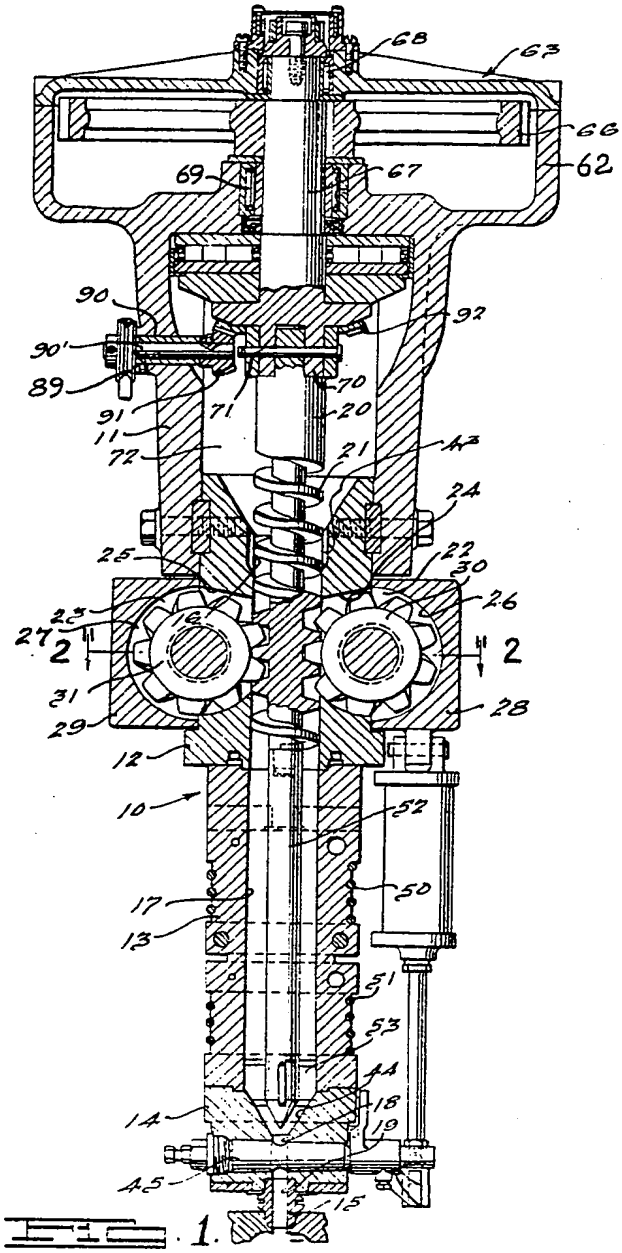
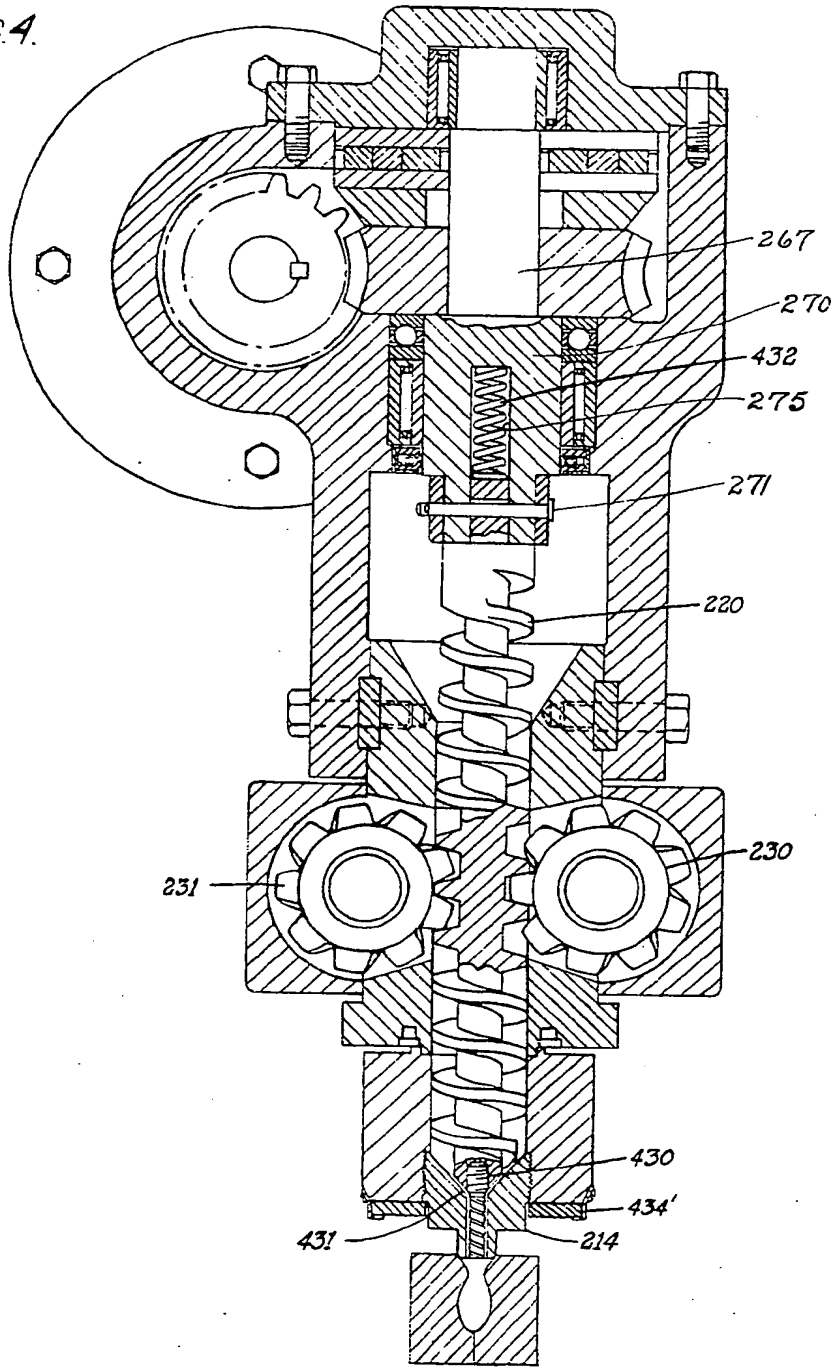


FIG. 1.

FIG. 4.



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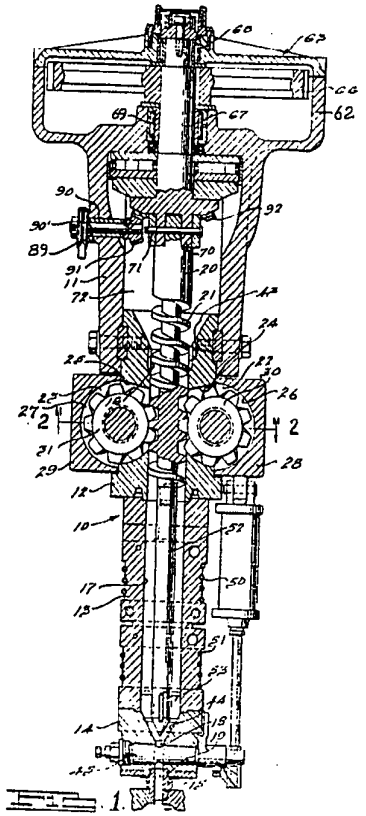
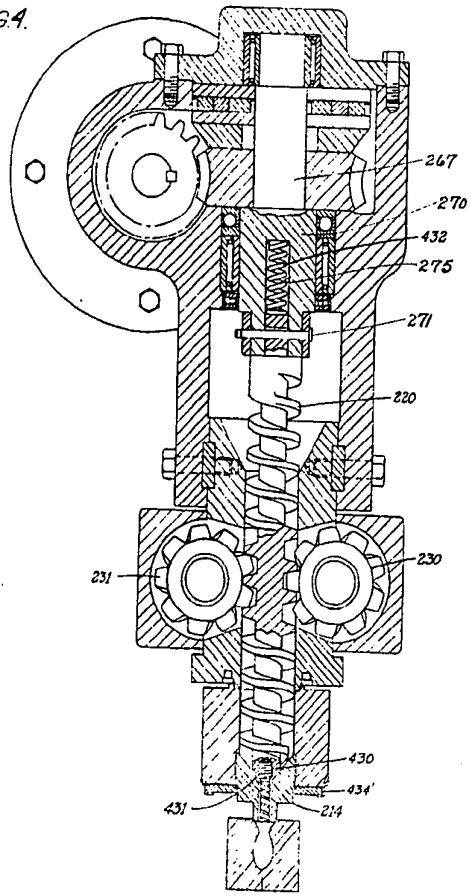


3 SHEETS
SHEET 3

FIG. 4.



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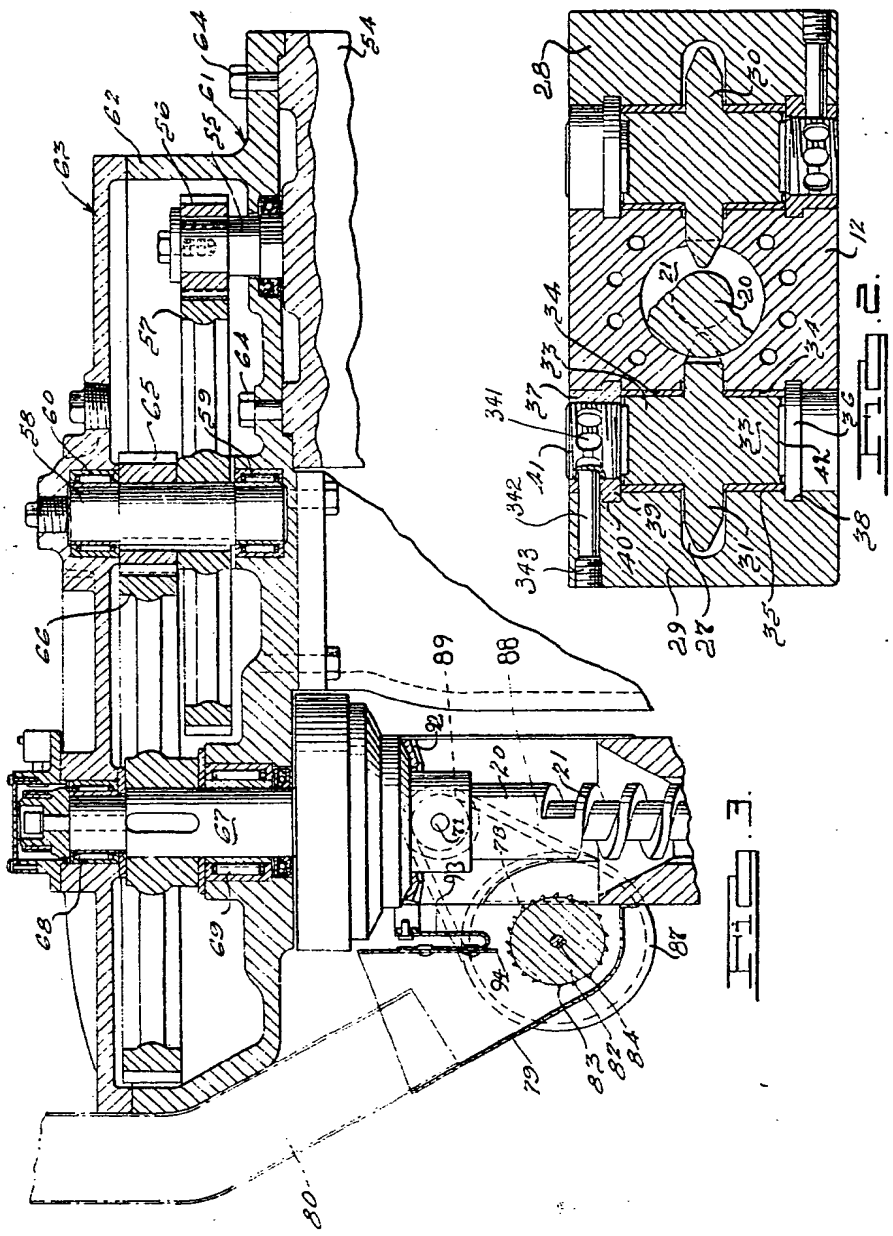

FIG. 2.

FIG. 3.